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ered Europe from Portugal to the foothills of Caucasus have disappeared, the mountains of Persia have become naked rocks and the promised land is a desert; but the Sunda Islands, Southern India, Siam, Ethiopia and the birthland of the Nile are still as sylvan and as prolific of life as in the springtime of creation. Not only the ocean but the vegetation of the tropics can defy "the vile strength, which man for earth's destruction wields," and Macauley's New Zealander who might visit the desert relics of American cities after musing over the ruins of London, would still find the primeval forests that covered the southern part of our continent when Humboldt and Bonpland explored the valley of the Amazon.

"These forests will be felled," says De Tocqueville, speaking of the Calaveras cedar groves, "they will disappear as the cedars of Lebanon and the mountain-firs of Scotland have disappeared; these and all other forests of the cold and temperate zones. The trees of the tropical woodlands are the only true evergreens on earth."

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ON LIKE MECHANICAL (STRUCTURAL) CONDITIONS AS PRODUCING LIKE MORPHOLOGICAL EFFECTS.

BY JOHN A. RYDER.

APROPOS of the interest recently manifested in the matter of "the relation of animal motion to animal evolution,"[1] I have thought it pertinent to offer the following remarks. The possible morphological effects of like mechanical or structural conditions are illustrated in the vertebral axes of turtles and extinct armadilloes (*Hoplophoridæ*), where the rigid exoskeleton (carapace) has caused the originally segmented axial skeleton to exhibit a strong tendency to revert to the primitive homogeneous (notochordal) condition, without at the same time losing its osseous character. The exoskeleton in both these groups has assumed in part the function of the chitinous exoskeleton of articulates. The vertebral axis relieved in both instances from the transverse flexures incident to locomotion and respiration, has coössified into a solid bony bar, or rather a hollow tube, with loss of the cylindroid form of centrum. The vertebral centra are in both represented

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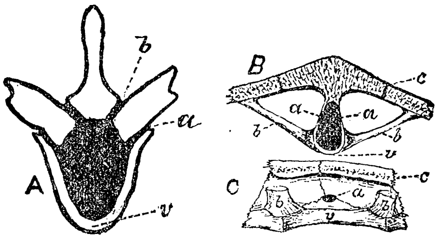
[1] See E. D. Cope in this Journal for January, 1878.



A, transverse section through the "dorsal tube" of *Panocthus tuberculatus*, reduced, after Burmeister. B, the same through the dorsal region of a salt-water terrapin (*Malacoclemmys*), original. C, side view of dorsal vertebra of *Emys europæa*, after Bojanus.

by the inferior wall of the "dorsal tube," *v* in the cut.[1] The extremital portions of the axes in both, manifest more or less distinctly the action of flexion in preserving the axial elements separate, since, in the necks and tails of both, there still remains more or less of mobility. In both, the union of the vertebræ has resulted in a similar disposition of the lateral foramina for the exit of the spinal nerves, that is, these open midway of the length of the vertebræ, piercing the lateral wall of the dorsal tube, and not passing out laterally between the bony arches of the neural canal, as happens in other vertebrates (see A, *a*, B, *a* and C, *a*, of cut). The reduction of the centra in the higher tortoises is, as should be expected, much more manifest than in the lower forms, and the union with the carapace, though not extensive, is manifested in the armadilloes by sutural union in the lumbar region. Similar structural alterations, which are believed to be similarly due to alterations in the mechanical relationship of the skeletal elements, are to be observed in the sacra of birds and mammals where the ilia have been greatly elongated so as to prevent lateral flexures of this portion of the column. The ribs in turtles have been involved in the dermal ossifications, and are therefore, as should be expected (B, *b* and C, *b*), united to the vertebral axis by suture; this is not the case in the *Hoplophoridæ*, where, owing to the preservation of the more highly specialized mammalian respiratory apparatus, the vertebro-costal articulations are still preserved, with loss in large measure of movement in an outward direction of their sternal ends. The costal movement was probably from behind forwards, with return, since the only articulation of the thoracic axial skeleton which is preserved, is that between the twelfth dorsal vertebra and first lumbar. *A priori* we should expect the phylogenetic history of the vertebral axes of the order

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[1] A similar degeneration and anchylosis of the centra is observed in the cervical vertebra of *Dipodomys*, as I have recently ascertained from a specimen sent me by Dr. Coues.

of Chelonians to agree with ontogenetic history or embryology of the individuals of the highest family. This, so far as I have been able to make investigations, proves, in a measure, to be the case, for it is observed that that portion of the vertebral axis included within the carapace in a young *Cistudo* has the vertebral centra more nearly of the character of the same parts of the lowest turtles, which approximate in the development of their centra to the normal or usual types of vertebrates with segmented axes. The degeneration of the vertebral axis in *Cistudo* into a mere tube, with exceedingly thin walls for the lodgment of the spinal cord, may probably be regarded as an instance of Cænogenesis.

These observed coincidences, it is believed, are neither accidental nor designed by an active cause external to these organisms or their cosmic environment. I would rather believe that the structures, so far as they have been evolved in parallel or similar ways, are the results of like forces conditioning growth and nutrition in definite modes and determinate directions. The manner of incidence of the modifying forces being in all cases determined by the voluntary actions of the organisms; the actions in turn are determined by the degree of intelligence of the animal manifesting them.

The origin of dermal ossifications is to my mind rationally explained by supposing the bioplasm of each dermal cell as sensitive and irritable to rude or violent external impacts, which, oft repeated, act as stimuli of growth force, determining certain tracts of these cells as the nidus within which osseous particles eventually appear as nuclei of the future defensive dermal bony system. This happens in the true skin and not in the corneous epiderm, which is still retained in more or less rudimentary condition in both Chelonians and Armadilloes, though it is not to be forgotten that in the toothless old-world Edentata it is the epiderm which becomes the defensive covering. This thickening, though not depending upon peculiar movements of portions of the body, as in the origin of hoofs, horns, etc., of other forms, depends upon the motion of the whole body mass, during which the hurtful stimulating impacts with the environment take place; so that the *rationale* of the origin of dermal ossifications is finally resolved into terms of osteoblasts and animal motion. The likeness of the process of the evolution of a defensive osseous or corneous derm, as sketched above, to the process of reparation in wounds is very great, indeed, in no essential are they different, except that the former usually goes forward in a bilaterally symmetrical way, while in the latter it most frequently does not.

The preceding facts and considerations embrace what may be regarded as the complementary principle demonstrating the mechanical theory of axial segmentation or origin of vertebræ, as proposed by Spencer, since it must be allowed, that if segmentation is due to flexures of the vertebral axis, conversely, union, coössification of segments, is due to their absence, because opposite conditioning causes must produce opposite effects in two things respectively so conditioned.

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ON THE TRANSPIRATION OF PLANTS.[1]

BY J. M. ANDERS, M.D., PH.D.

IN looking over the literature of the subject, one is surprised to find how little definite knowledge we possess in regard to the process of plant transpiration. When the importance of the subject is considered, there would seem to be no explanation for this apparent omission of research.

It has been pretty well established that transpiration is produced and modified by influences acting from without, and by the structural peculiarities of the plant. Most important among the former modifying agencies are sunlight, wind, dew point and temperature ; and among the latter circumstances is to be mentioned, more particularly, the nature of the epidermal tissue. The precise connection between these various conditions and the amount of water evaporated has not been investigated to any considerable extent; and the most important question, viz.: the amount of liquid ordinarily transpired by different plants has, also, hitherto been quite as sadly neglected.

A few bare statements are made in relation to the quantity of transpiration (Gray's Structural and Systematic Botany). A sunflower 3½ feet high, with a leaf surface of 5616 square inches, when exposed to the air, evaporated from 20 to 30 ounces in twelve hours, being seventeen times as fast as man exhales. A seedling apple tree, with leaf surface amounting to 112 square feet, evapo-

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[1] The Geo. B. Wood prize essay, 1877, read before the Society of the Alumni of the Auxiliary Dept of Medicine, University of Pennsylvania.